California Division of Mines and Geology

Fault Evaluation Report FER-86

March 21, 1979

1. Name of fault group

Branches of the San Andreas fault system, including the Mission Creek fault, the Banning fault, the Garnet Hill fault, and other local fault segments.

2. Location of faults

Within the Desert Hot Springs and Seven Palms Valley quadrangles, Riverside County, California (see Figure 1).

3. Reason for evaluation

This area lies within the 1978 study area of the 10-year program for fault evaluation.

4. List of references

Allen, C.R., 1957, San Andreas fault zone in San Gorgonia Pass, southern California: Geological Society of America Bulletin, v. 68, n. 3, p. 315-350.

Brown, G.A., 1974, Report of geologic and seismic study, Angel View Hospital property, 12-379 Miracle Hill Road, Desert Hot Springs, Riverside County, California. Unpublished consulting report for Angel View Crippled Children's Foundation, Inc.,CDMG Hospital report, file Number H-0880.

California Division of Mines and Geology, 1974, Special Studies Zones Official Map, Desert Hot Springs quadrangle.

California Division of Mines and Geology, 1974, Special Studies Zones Official Map, Seven Palms Valley Quadrangle.

Hope, R.A., 1969, Map showing recently active breaks along the San Andreas and related faults between Cajon Pass and the Salton Sea: U.S. Geological Survey open-file map.

Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, California Geologic Data Map Series, Map No. 1, Scale 1:750,000.

Proctor, R.J., 1968, Geology of the Desert Hot Springs-upper Coachella Valley area, California: California Division of Mines and Geology Special Report 94, 50 p., pl. 1.

Rasmussen, G.S., 1977a, Engineering Geology investigation, 6 acre parcel Angel View Crippled Children's Foundation, Desert Hot Springs, California. Unpublished consulting report for Deloris Kiester, Desert Hot Springs, California. A-P file number C-331.

Rasmussen, G.S., 1977b, Engineering geology investigation, 5 acre parcel, SW corner of La Salle Road and Hacienda Avenue, Desert Hot Springs, California. Unpublished consulting report for Rimas Gurcinas, Los Angeles, California. A-P file number AP-908.

Rasmussen, G.S., 1977c, Engineering geology investigation, 40 acre parcel NW corner, 19th Avenue and Palm View, Desert Hot Springs, California. Unpublished consulting report for Marilyn R. Smith, Desert Hot Springs, California. A-P file number AP-626.

Rasmussen, G.S., 1977a, Subsurface engineering geology investigation, 2 1/2 acre site south of Dillon Road and west of Corkhill Road, Desert Hot Springs, California. Unpublished consulting report for Boyle Engineering, San Bernardino, California. A-P file number AP-921.

Rasmussen, G.S., 1979b, Engineering geology investigation, 100-acre parcel, north of Dillon Road east of Long Canyon Road, Desert Hot Springs, California. Unpublished consulting report for Boyle Engineering, San Bernardino, California. A-P file number AP-922.

Real, C.R., Parke, D.L., and Toppozada, T.R., 1977, Magnetic tape catalog of California earthquakes, 1900-1974: California Division of Mines and Geology.

Smith, D.P., 1979, The San Gorgonio Pass fault. Unpublished report, California Division of Mines and Geology Fault Evaluation Report FER-87, 6p.

Aerial photography

Designation: 4-01-30
Date: 1930
Scale:
Type: black and white, vertical stereo
Coverage: Banning fault, Whitewater River to Mecca Hills.
Availability: California Division of Mines and Geology, Los Angeles District Office.

Designation: Fairchild C-6060
Date: September, 1939
Scale: 1:18,000
Type: black and white, vertical stereo
Coverage: Desert Hot Springs and Whitewater River area.
Availability: Fairchild aerial photography collection, Geology Department, Whittier College, Whittier, California, and California Division of Mines and Geology, San Francisco District Office.

Designation: Fairchild C-16107
Date: January 31, 1951
Scale: 1:19,680
Type: black and white, vertical stereo
Coverage: Desert Hot Springs area.
Availability: Fairchild aerial photography collection, Geology Department, Whittier College, Whittier, California.

Designation: WRD-5D6
Date: June 17, 1966
Scale: 1:14,600
Type: black and white, vertical stereo
Coverage: All of the San Andreas and other major faults in California, including the Banning fault.
Availability: California Division of Mines and Geology, Los Angeles District office, Los Angeles, California.

5., 6., and 7. Summary of available data, interpretation of aerial photography, and field observation

There are two principal branches of the San Andreas fault system in the Desert Hot Springs area: the Mission Creek fault and the Banning fault (Figures 3 and 4). Both of these faults pass through the Desert Hot Springs and Seven Palms Valley quadrangles. Both faults show abundant evidence of

Pleistocene and Holocene movement. Another fault, the Garnet Hill fault, is parallel to and lies about 3 km to the south of the Banner fault (Figure 4). Numerous small, local fault segments have also been recognized within the two quadrangles, and some of these have been included within special studies zones (Figure 4).

Allen (1957) made detailed maps of parts of the Banning and Garnet Hill fault zones in the San Gorgonio Pass area. His mapping extended into the westernmost part of the Desert Hot Springs quadrangle. Hope (1969) did reconnaissance mapping of the Mission Creek, Banning, Fun Valley, and Blind Canyon faults. Proctor (1968) mapped a large area of this region, including nearly all of the Desert Hot Springs and Seven Palms Valley quadrangles. He recognized and delineated all of the faults shown on Figures 3 and 4, except for the DHS-B fault (Figure 3a). At least 21 subsurface investigations have been conducted along faults in the Desert Hot Springs area (Figure 4).

Figure 4 shows the special studies zones that were established in 1974 in the Desert Hot Springs area. These zones were established entirely on the basis of mapping done by Allen (1957), Proctor (1968), and Hope (1969). At that time, no additional mapping or field checking was done by CDMG personnel. The present study has included much ground checking (note annotations on Figure 4) and much remapping, both on the ground and from aerial photos (Figure 3).

Banning Fault

I remapped the Banning fault, mainly on aerial photos (4-01-30, 1930; Fairchild C-6060, 1951; and WRD-5D6, 1966). The geomorphic features along this fault are very visible on the photos because of the barren desert terrane. My depiction of the fault (Figure 3) is generally similar to that of previous workers as compiled on the Desert Hot Springs and Seven Palms Valley quadrangles SSZ maps (Figure 4). However, there are several differences in detail. The locations are slightly different along various parts of the fault. This is primarily a difference in plotting. I had the advantage of using a Zoom Transfer Scope in Transferring my mapping from photos to topographic base map. I believe, therefore, that my locations (Figure 3) are more accurate than those of my predecessors. Also, I have been less inclined to infer the fault (dotted lines) where specific surface evidence is not visible. Thus, my mapping appears to be somewhat less complete. There are also differences between my mapping and that of my predecessors, in regard to the interpretation of what does or does not constitute a fault-related feature. These differences do not necessarily mean that the earlier workers and I all perceive the fault differently. Rather, the features that occur along this fault, as with many other faults, range from the obvious to the obscure. There is always a "gray area" where, based on surface evidence alone, it is impossible to determine whether a given feature is related to a fault trace or is of some other origin. Thus, it is unlikely that any two workers will map the fault, and its minor branches in exactly the same way. The Seven Palms Valley and Willow Hole areas (Seven Palms Valley quadrangle) are good examples of this problem. There, the Banning fault appears to separate into many branches. That area has also been exceedingly modified by eolian processes. In fact, the problem is compounded because the prevailing winds blow in a direction nearly parallel to the fault zone. Thus, linear features generated by the wind are easily confused with the fault-generated linear topography. All workers (Proctor, 1968; Hope, 1969; and myself) have mapped this area substantially differently from one another, and until a significant amount of subsurface work is done, these disparities cannot be resolved. I have, however, indicated my disagreement with the mapping of certain traces that lie to the northeast of the main zone of faulting in the Seven Palms Valley area. I believe the evidence there is too weak to warrant the interpretation of these features as being fault traces. The reasons are given in the annotation (Figure 4b).

To the southeast of Willow Hole, I have mapped the Banning fault only a short distance into the Indio Hills. Within the hills, rapid erosion of the terrane reduces the usefulness of aerial photography in recognizing the course of the fault; ground work is much more necessary in that area. Because of time limitations, I was unable to complete my remapping of the Banning fault to the southeast. Likewise, I was unable to remap the Mission Creek fault any farther to the southeast than is shown on Figure 3b.

To my knowledge, no subsurface investigations have been conducted along that part of the Banning fault that passes through the area of consideration in this FER.

Mission Creek Fault

The generalizations made about my remapping of the Banning fault apply as well to the Mission Creek fault. The specifics, of course, are different. There is a major error in the location of the fault trace in the central part of the Seven Palms Valley quadrangle SSZ map (Figure 4b). That depiction of the fault trace is taken from Proctor (1968). The fault-generated surface features actually lie about 200 m to the southwest, as shown on Figure 3b.

Subsurface investigations at three sites along this part of the Mission Creek fault (AP-626, AP-921, and AP-922), confirm the location of the fault as shown on Figure 3b. There are also some significant differences in my remapping of the Mission Creek fault in the vicinity of the town of Desert Hot Springs. Land subdivision and urbanization had largely destroyed the fault-generated surface features by some time shortly after World War II. However, we obtained some older photography (Fairchild C-6060, 1939) that predates the destruction of the fault features through the town. Thus, I was able to map the fault directly through the town (Figure 3) rather than inferring it as the previous workers did (Figure 4). One subsurface investigation (AP-597, Figure 4a) was conducted along this part of the fault; it confirmed the location of the fault as seen on the photos. Furthermore, I was able to see topographic features generated by an older (?) branch of the fault that lies 300 m to 400 m northeast of the principal trace of the Mission Creek fault. This branch occurs between the town of Desert Hot Springs and Miracle Hill to the southeast. It has sometimes been referred to as the Miracle Hill fault. Note that my mapping of this fault (Figure 3b) differs considerably from the inferred fault mapped by Proctor (1968) - - which is shown on the SSZ map (Figure 4b). Rasmussen exposed the Miracle Hill fault in a trench (AP-908, Figure 4b) - - at the same location as I mapped the fault on the basis of the 1939 aerial photo evidence. Several other trenching investigations, to the northwest, across or near the inferred trace shown on the SSZ maps, failed to find a fault.

Farther to the northwest, where the Mission Creek fault converges with the southern edge of the Little San Bernardino Mountains, there are again some noticeable differences between my mapping (Figure 3a) and the SSZ map (Figure 4a). The depiction of faulting on the SSZ map is taken mainly from Proctor (1968). I show far fewer traces in this area than Proctor does.

However, I have shown only those traces which appear to have been active in latest Pleistocene time or Holocene time. Some of the branches farther to the northeast that Proctor mapped do not appear to have been active that recently. But, because they cut crystalline basement rock, they remain readily visible even though they may have been inactive since well before Holocene time. Thus, when I prepared my map, I made a judgement, based on geomorphic youthfulness, as to which branches are still part of the active Mission Creek fault zone. Those branches are the ones I have shown on Figure 3a.

I do not see any surface evidence for the Mission Creek fault through a 3 km-long area extending northwestward from the town of Desert Hot Springs to the edge of the Little San Bernardino Mountains. This area is mostly underlain by the very active Little Morongo Canyon alluvial fan. It is probable that any surface features that were generated by the Mission Creek fault were rapidly washed out or buried by the alluvial fan. I see no evidence to support the alternative interpretation that the fault is simply less active across this area.

Garnet Hill Fault

I see no specific surface evidence for the location of this fault in either the Desert Hot Springs or Seven Palms Valley quadrangles. Proctor (1968, p. 30) infers this fault on the basis of a gravity anomaly detected by an oil company. At the very western edge of the Desert Hot Springs quadrangle, Allen (1957) mapped the Garnet Hill fault (see dashed line on Figure 4a). Allen's symbol for the fault (on his Plate 1) indicates surface evidence for the fault. I examined the area closely on photography flown in 1951 and more recently, and saw no such specific evidence for the fault within the Desert Hot Springs quadrangle. Farther to the west, at the mouth of Whitewater Canyon, I do see specific evidence for the fault. Those features are described in FER-87 (Smith, 1979).

DHS-A fault

This feature, which lies near the northeastern corner of the Desert Hot Springs quadrangle (Figure 4a), was mapped by Proctor (1968). I examined the feature on the ground and concluded that it is probably not a fault, but an erosional feature due to differential resistance of lithology in banded metamorphic rock. On aerial photos, the feature looks very much like a fault, although it is anomalously short in length. In any case, older alluvial terrace surfaces cross the feature without offset.

DHS-B fault

This fault lies near the center of the Desert Hot Springs quadrangle (Figure 3a). It was not mapped by previous workers in this area. The fault is characterized by a northwest-facing scarp that ranges from 1 m to 4 m in height, and exhibits a maximum slope angle of about 22°. The existing scarp is only about one kilometer in length; the continuations in both directions have apparently been destroyed by active alluvial outwash from the northwest. The scarp is moderately dissected, and its youthfulness of appearance varies, with the higher scarps appearing to be more recent. This fault appears to have some relationship to the Devers Hill uplift.

Blind Canyon Fault

This fault occurs near the northwestern corner of the Seven Palms Valley quadrangle. As it is shown on the SSZ map (Figure 4b), it represents a compilation of the mapping of both Proctor (1968) and Hope (1969). Parts of this fault are clearly visible on older aerial photos, especially the northern part where an older alluvial surface and a bedrock pediment surface are clearly offset in a vertical sense. Those scarps no longer exist, as that area was recently modified by large-scale cut-and-fill landscaping. I examined the central and southern parts of this fault on the ground. I observed the fault to cut both the crystalline basement rock and a very old alluvial unit that overlies the basement rock in some places. Another older alluvial unit, and surface, which overlay the above two units, is not offset by the fault. I believe that the surface is older than Holocene age. I observed additional exposures of the fault near the southern end (see annotations on Figure 4b). There the fault is exposed in deep stream cuts. An older alluvial unit is faulted, but the faulting extends only to within about 3 m of the surface of that unit. I believe that the surface may be older than Holocene age. An exploratory trench by Brown (1974) located about 100 m west of the southern part of the fault (see Figure 4b for trench location) uncovered no evidence for faulting. Rasmussen (1977a) conducted trenching across the northern end of the fault (trench C-331 on Figure 4b), observed the fault in two of the trenches, and concluded (p. 8) that the Blind Canyon fault is "...possibly an active fault based on the definitions for active faulting provided by the State Mining and Geology Board." In other words, he is saying that the fault may have been active during Holocene time. I disagree. I examined the area of Rasmussen's trenching on older photography (Fairchild C-16107, 1951). At that time, this area had not been disturbed by the activities of man. The northeast-facing scarp mentioned by Rasmussen (p. 7) is clearly visible. However, the scarp is highly eroded, and dissection extends deeply into both the upthrown and downthrown sides of the fault. Furthermore, the area that Rasmussen investigated is nearly identical in geomorphic appearance to the area that I examined on the ground about one kilometer to the south along the fault. Because of this similarity, I tend to draw the same conclusion about recency of fault movement; none has occurred during Holocene time. Rasmussen believes that the faulted sediments on the southwestern side of the fault are of Holocene age. But he mentions, and shows on his logs (trench 1 and pit 1), that there are abundant caliche-filled cracks in that unit. It is my belief, based on the observation of many sedimentary units in this region, that significant accumulations of caliche occur only within alluvial units that are much older than Holocene.

SPV-A Fault

This is steeply-dipping, west-northwest-trending fault that occurs in the north-central part of the Seven Palms Valley quadrangle (Figure 4b). It was mapped by Proctor (1968) as part of the Dillon fault zone. I examined the eastern half of this fault on the ground. The fault is characterized by a 15 cm to 20 cm wide gouge zone within a 15 m to 30 m wide mildly cataclastic zone. The fault generally lies beneath the modern alluvium of the canyon bottom, but locally is exposed in the granitic and metamorphic bedrock of the canyon walls at bends in the canyon. There is no direct evidence for or against Holocene offset. The modern alluvium is not faulted, and there are no older alluvial deposits along this canyon. Where the faulted bedrock is exposed, the geomorphic features do not suggest movement as recent as Holocene time.

SPV-B Fault

This is a north-south-trending fault that lies in the north-central part of the Seven Palms Valley quadrangle (Figure 4b). Proctor (1968) mapped this fault and called it the Long Canyon fault. I examined parts of this fault on the ground. I saw no evidence for offset of Recent-Holocene alluvium at the northern and southern ends of the fault, as indicated by Proctor (1968, Plate 1) (see annotations on Figure 4b). I observed faulting in the crystalline basement rock at several localities. Along the southern third of the fault, the trace lies a short distance into the eastern wall of the canyon, instead of passing directly down the middle of the canyon as shown on Figure 4b. Remnants of an older alluvial surface on the eastern side of the canyon appear to have been faulted with the western side upthrown about one meter. The topographic expression of this offset is very indistinct, suggesting that the faulting there has not been recent. Farther to the north, in the central part of the fault, an older alluvial terrace surface overlying the fault has not been offset.

Exposures of this fault are poor, but they show the fault to be vertical or steeply dipping.

SPV-C Fault

This is a northeast-trending fault that occurs to the west of Long Canyon (Figure 4b). The fault is exposed at several places in the crystalline basement rock, and shows a dip of 50° to the northwest accompanied by several inches of gouge. An overlying veneer of older alluvium is not cut by the fault. Proctor (1968, Plate 1) shows this fault cutting Recent alluvium at two places (see annotation, Figure 4b). I found no evidence for faulting of the Recent alluvium in those places.

SPV-D and SPV-E Faults

These fault segments occur near the southeastern corner of the Seven Palms Valley quadrangle (Figure 4b). The SPV-D fault was mapped by Proctor (1968) and the SPV-E fault was mapped by Hope (1969). The faults occur mainly within older alluvial strata of Pleistocene age. The geomorphic features along these two fault segments have been extensively modified by erosion. There is no surface expression of the faults along most of their lengths. Locally, I observed Holocene or older alluvium, that overlies the faults, to not be cut.

Fun Valley Fault

This fault lies about one kilometer to the northeast of the Mission Creek fault, in the eastern side of the Seven Palms Valley quadrangle (Figures 3b and 4b). The fault, as shown on the SSZ map (Figure 4b), represents mapping by both Proctor (1968) and Hope (1969). I have remapped it as shown with annotations on Figure 3b. I perceive this fault to be composed of several overlapping arcuate traces. Locally the geomorphic expression is very youthful (see annotation on Figure 3b). Although I could find no actual exposure of the fault place, I suspect that this fault is composed of a series of small, overlapping thrust plates, with southwest dipping fault planes converging with the Mission Creek fault at depth.

Seismicity

The "A" quality epicenter map (Figure 2) shows this area to have somewhat less seismicity than surrounding areas, especially to the south. Two epicenters appear to lie on the Mission Creek fault, and two on the Banning fault. This is fairly good correlation with those two faults. An unusually tight cluster of small magnitude events occurred just north of the DHS-B fault.

There are no events along the Garnet Hill fault, and only minor activity along the Dillon fault zone.

8. Conclusions

The Banning fault is clearly active through the two quadrangles under consideration in this report. There are a number of small, local branches of the Banning fault that I do not believe have been active in Holocene time. These, essentially, are traces shown on Figure 4 but not on Figure 3.

The generalizations stated in the above paragraph apply equally well to the Mission Creek fault. In addition, I conclude that there is a serious error in the location of the Mission Creek fault within the central part of the Seven Palms Valley quadrangle (as previously discussed in this report). Also, I see an insufficient amount of evidence to map the Miracle Hill fault as shown by Proctor (1968) (see Figure 4b), but do find sufficient evidence to map the fault as shown on Figure 3b.

I see no surface evidence for the Garnet Hill fault within the two quadrangles, and since we have no evidence, direct or indirect, that the fault has offset the surface, or even approaches within, say, 10 m of the surface, then I must conclude that this fault cannot meet our criteria for being sufficiently active and well-defined.

I conclude that most of the fault segments that lie to the northeast of the Mission Creek fault have not been active during Holocene time. These include the DHS-A feature, the Blind Canyon fault, and the SPV-A, SPV-B, and SPV-C faults. Not only is there a general lack of specific evidence for Holocene movement along these faults, but in many places there is specific evidence against Holocene movement.

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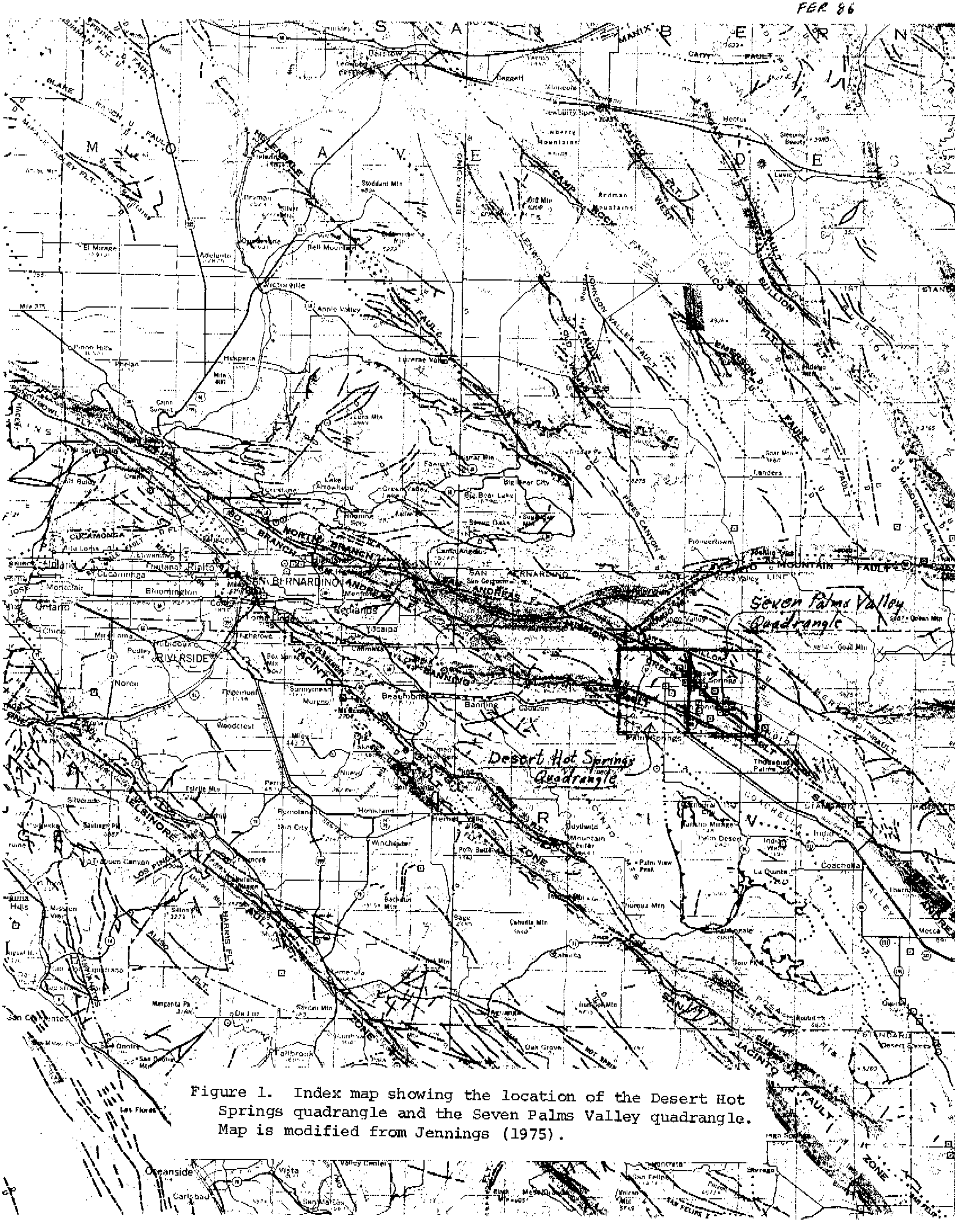


Figure 1. Index map showing the location of the Desert Hot Springs quadrangle and the Seven Palms Valley quadrangle. Map is modified from Jennings (1975).

I conclude that the evidence along the DHS-B fault is both suggestive and permissive of Holocene movement.

Parts of the Fun Valley fault segment exhibit youthful geomorphic features; I must conclude that there is a reasonable possibility that Holocene offset has occurred along this trace.

I conclude that the SPV-D and SPV-E fault segments have probably not been active since well before Holocene time. There is a strong lack of any evidence that could be construed as indicating Holocene movement.

9. Recommendations

I recommend the re-delineation of the Banning fault, primarily using the annotated mapping of that fault as shown on Figure 3. This should be accompanied by some narrowing and adjustment of the zone boundaries.

I likewise recommend re-delineation and zone adjustment for the Mission Creek fault. Changes should be made in several areas based upon the conclusions stated above.

I recommend the deletion of the Miracle Hill fault as presently shown on the official SSZ map (Figure 4), and then a new delineation of the fault as shown on Figure 3b, along with an appropriate change in the zone.

I recommend total deletion of the zone along the Garnet Hill fault.

I recommend total deletion of the zones along the DHS-A feature, the Blind Canyon fault, and the SPV-A, SPV-B, SPV-C, SPV-D, and SPV-E faults.

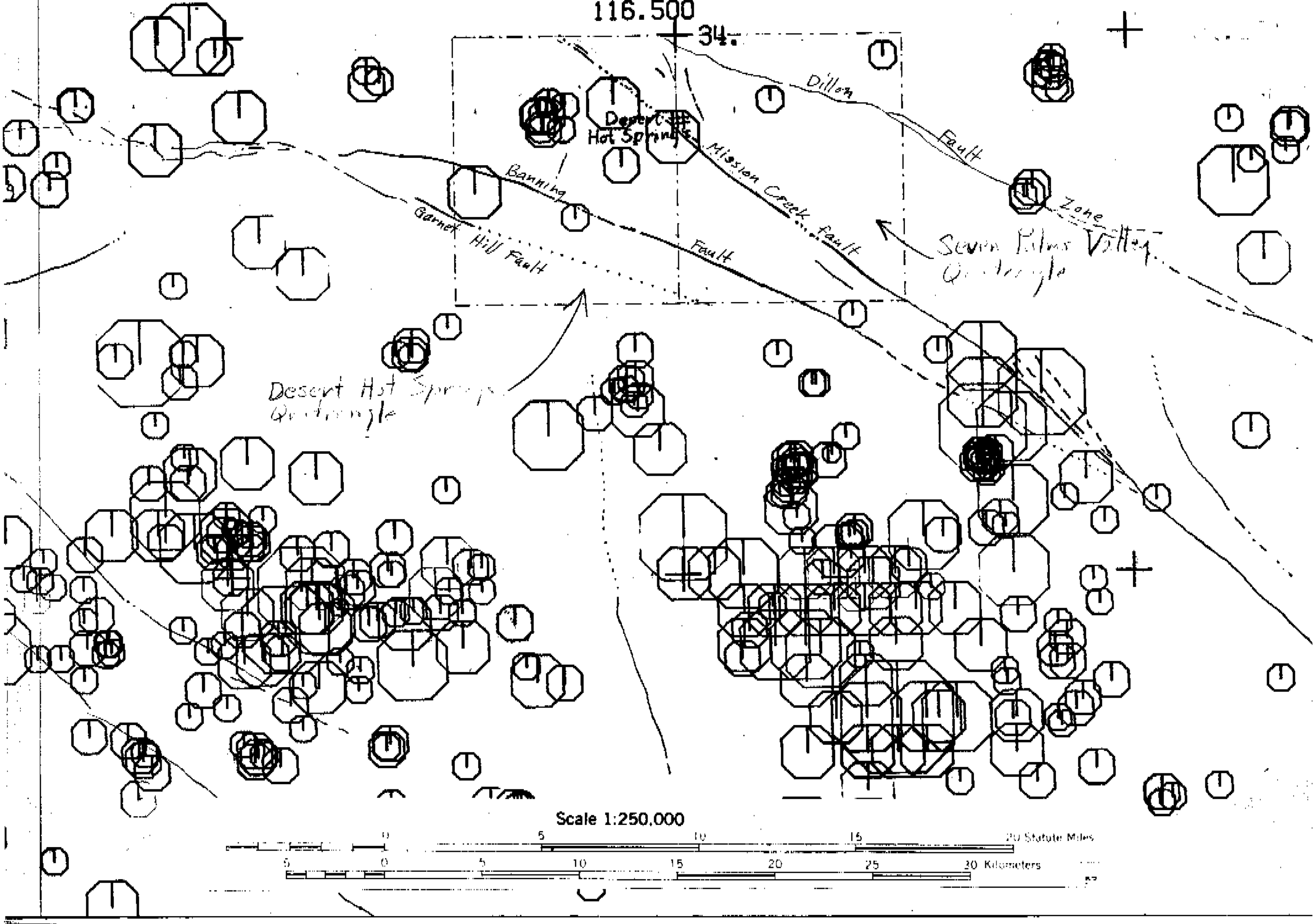
I recommend re-delineation of the Fun Valley fault, accompanied by appropriate zone adjustment.

10. Investigating geologist

I agree with the recommendations.
EWH
5/2/79

Drew P. Smith

DREW P. SMITH
April 30, 1979



EARTHQUAKE EPICENTERS IN SANTA ANA

TRANSVERSE MERCATOR PROJECTION

SCALE = 1/250000

"A" Quality Data

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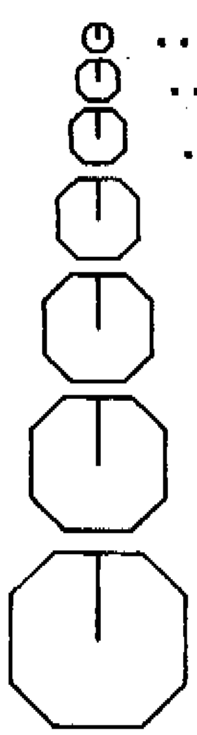

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Figure 2. Seismicity in the region of Desert Hot Springs.
"A" quality epicentral data plots from Real and others (1977).

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(DATA SOURCES ARE: FOR 1900-1931, CDMG SPECIAL REPORT 135; FOR 1932-1974, CALTECH AND U.C.BERKELEY FOR SOUTHERN AND NORTHERN CALIFORNIA RESPECTIVELY; AND SINCE 1969, THE USGS FOR CENTRAL CALIFORNIA. A COMPREHENSIVE CATALOG OF CALIFORNIA EARTHQUAKES IS AVAILABLE ON MAGNETIC TAPE AND MICROFICHE FROM CDMG.)

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES E. SLOSSON, STATE GEOLOGIST

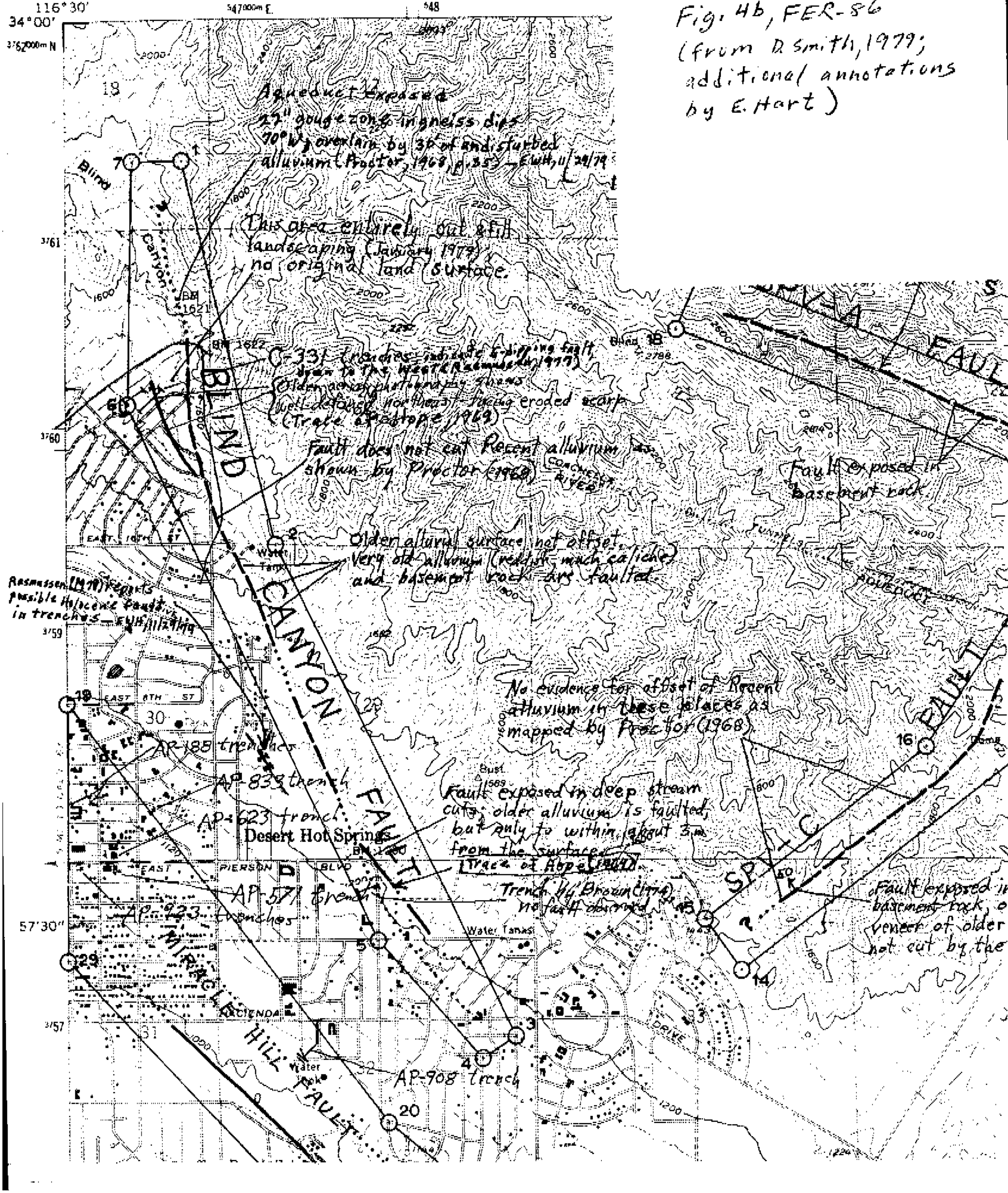
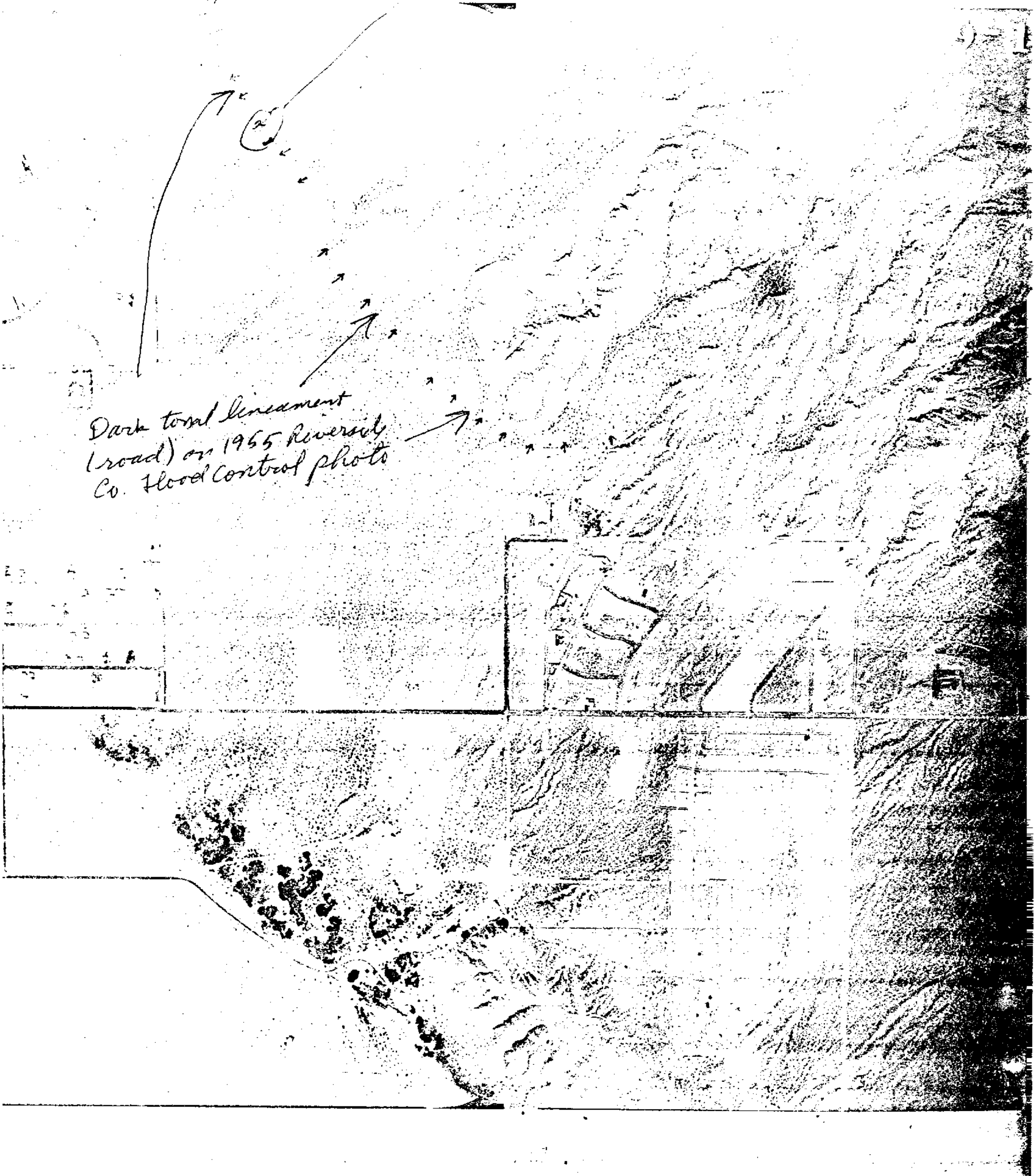


Fig. 4b, FER-86 (from D. Smith, 1979; additional annotations by E. Hart)

Approx. trench locations of Rasmussen, Tract 11851



Dark Tonal lineament on Riverside Co.
Flood Control photo 4-1 about here; this is a [illegible]
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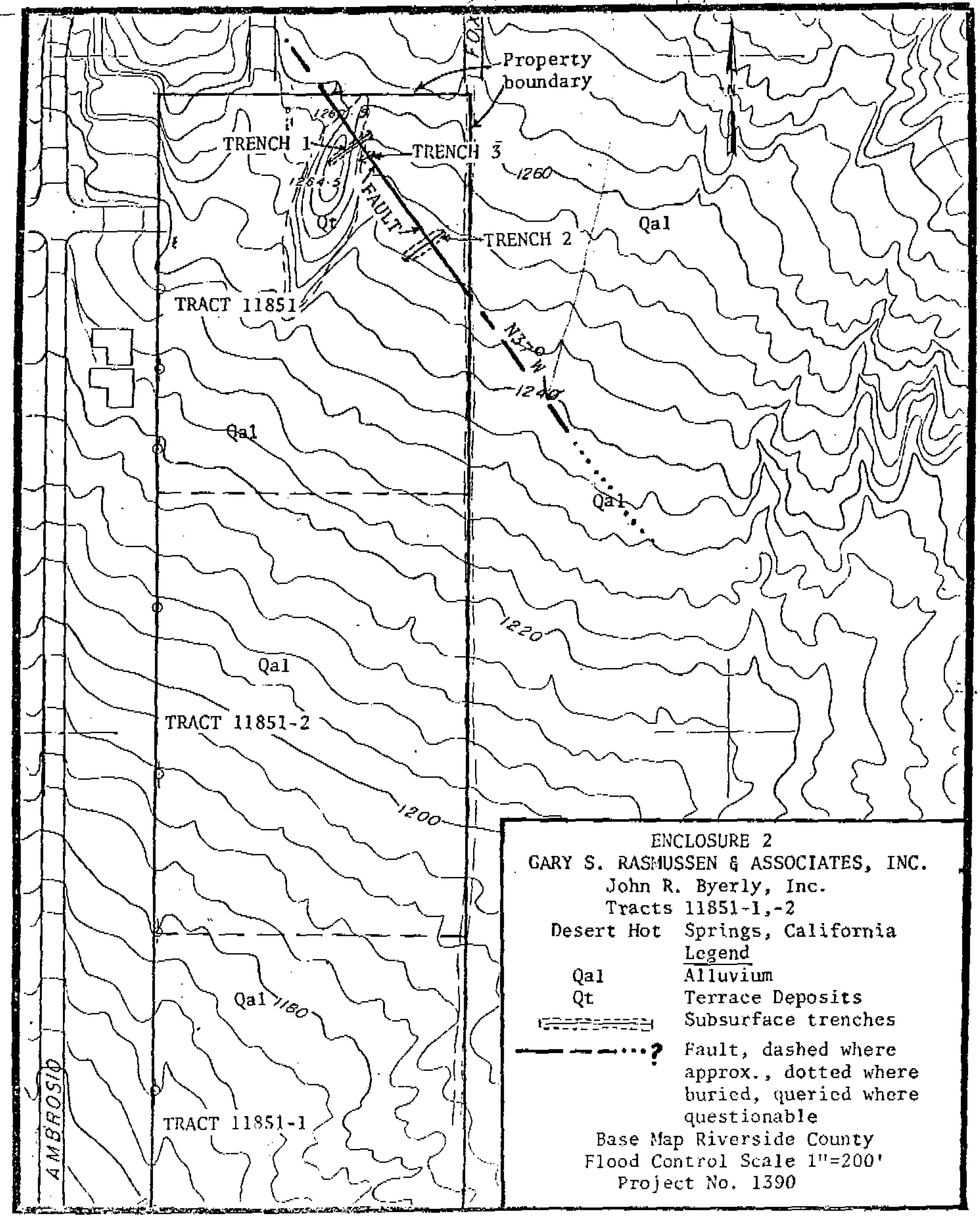
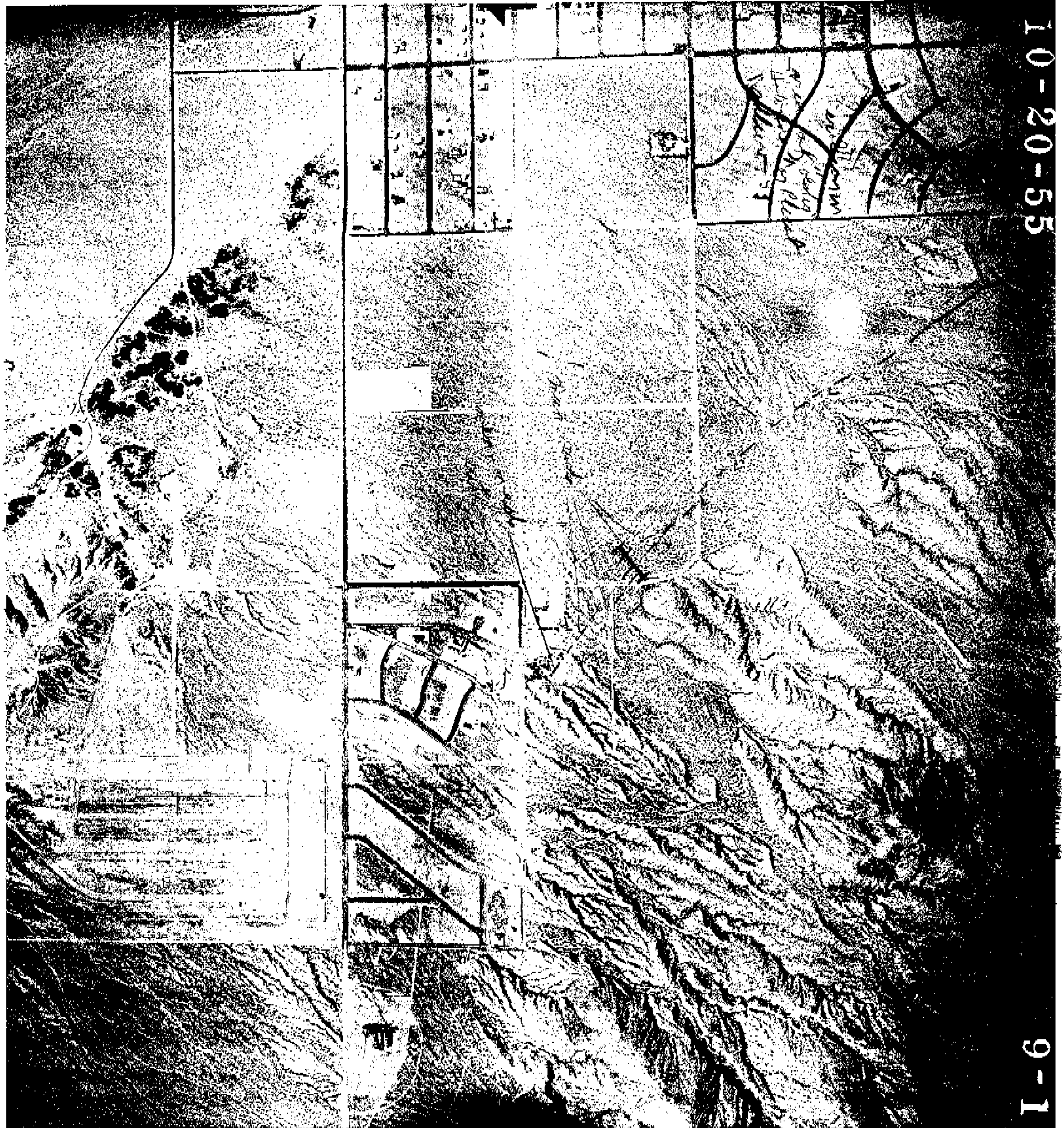
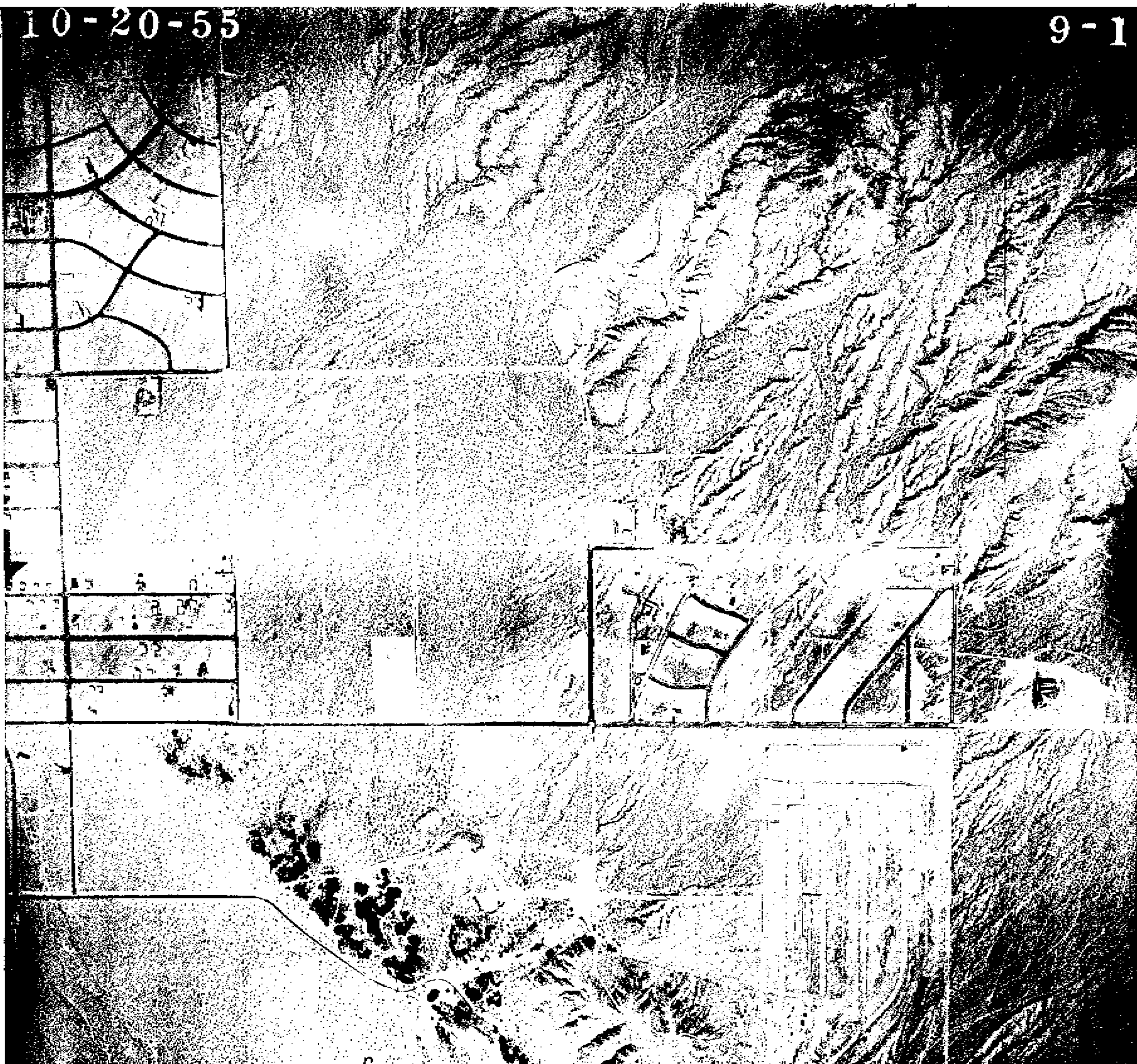


1955, 1957, 1966, 1970 airphotos of Blind Canyon fault -- all borrowed from Rasmussen (Riverside Flood Control), except 1966 WRD fr. LA district.

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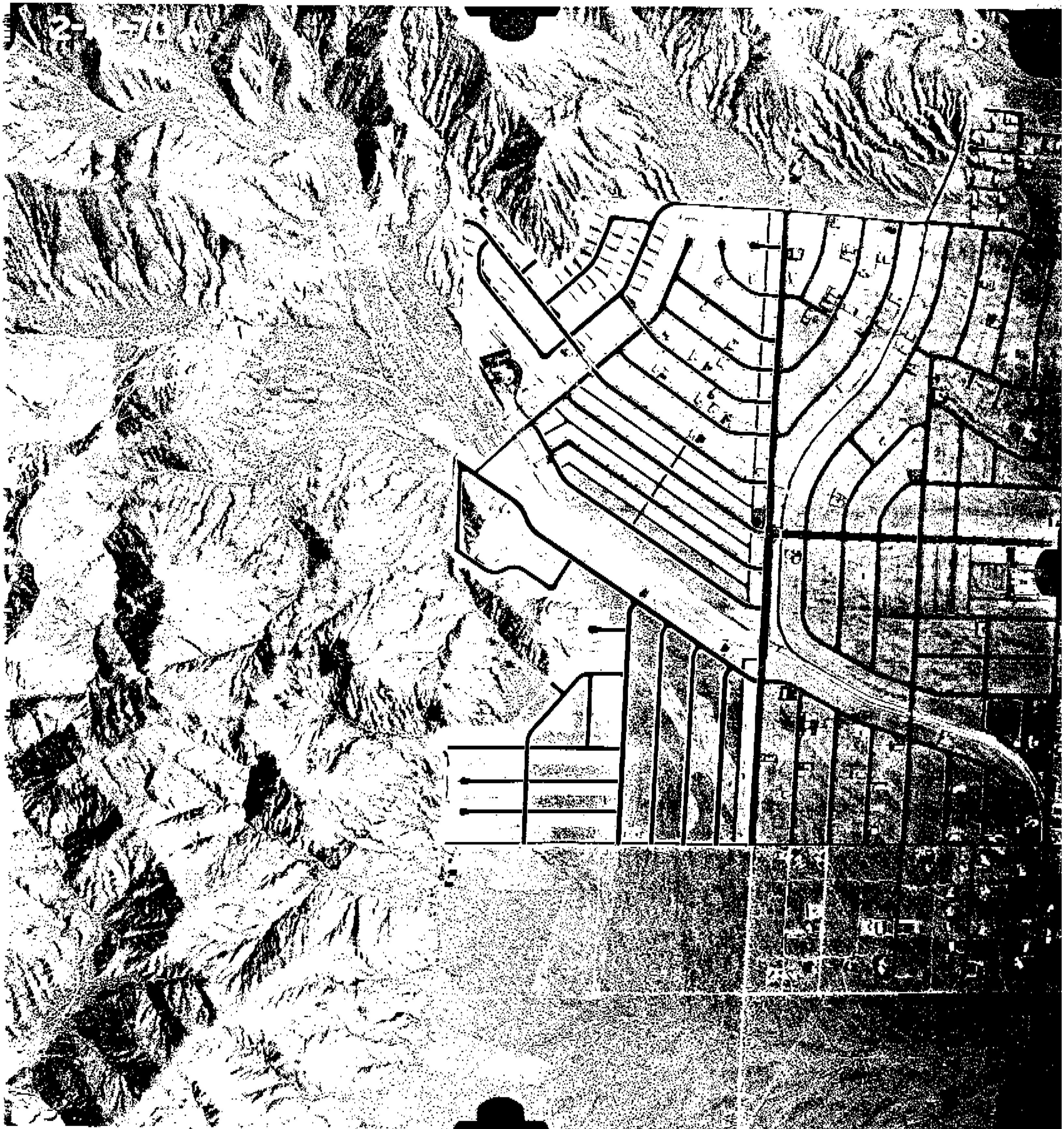


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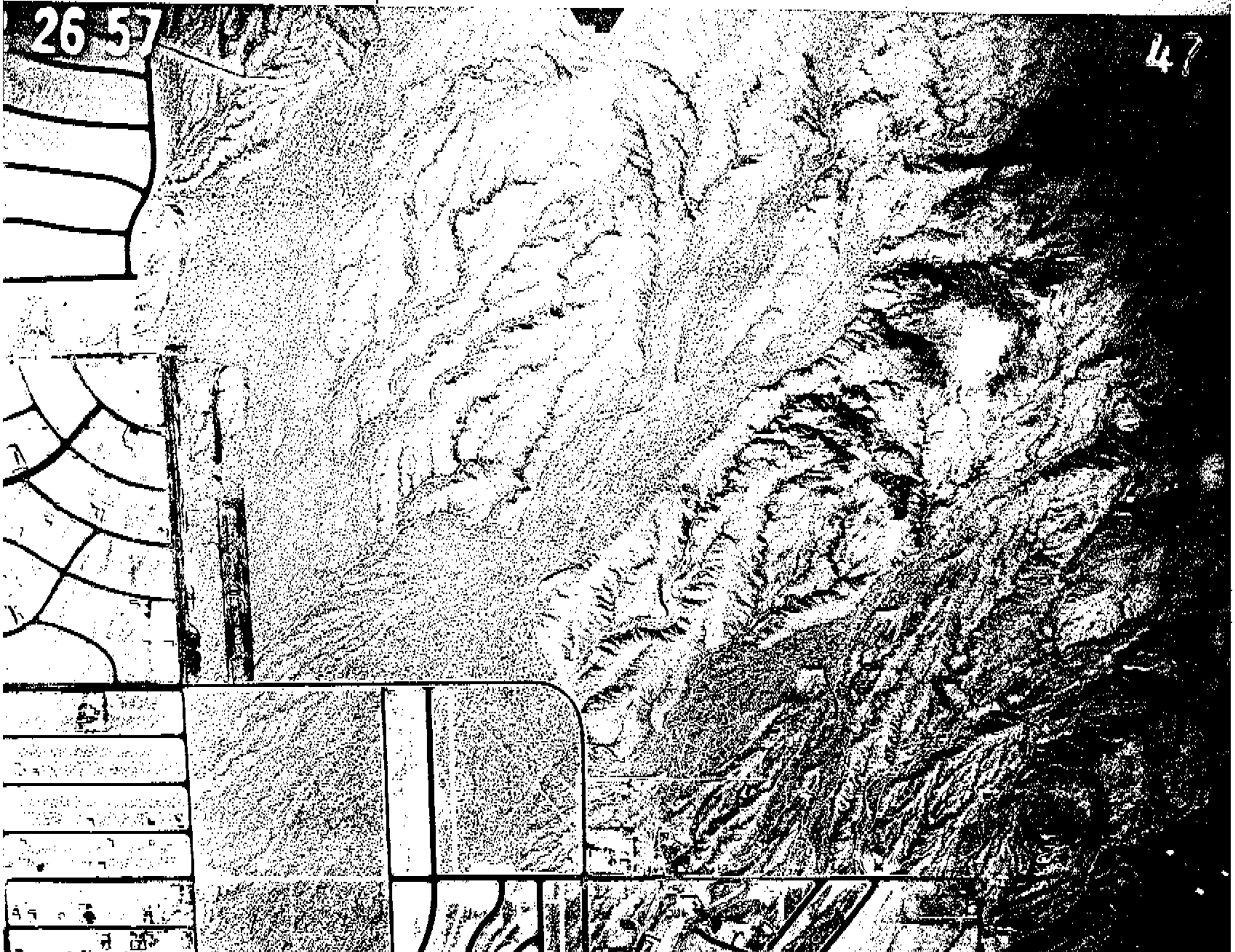
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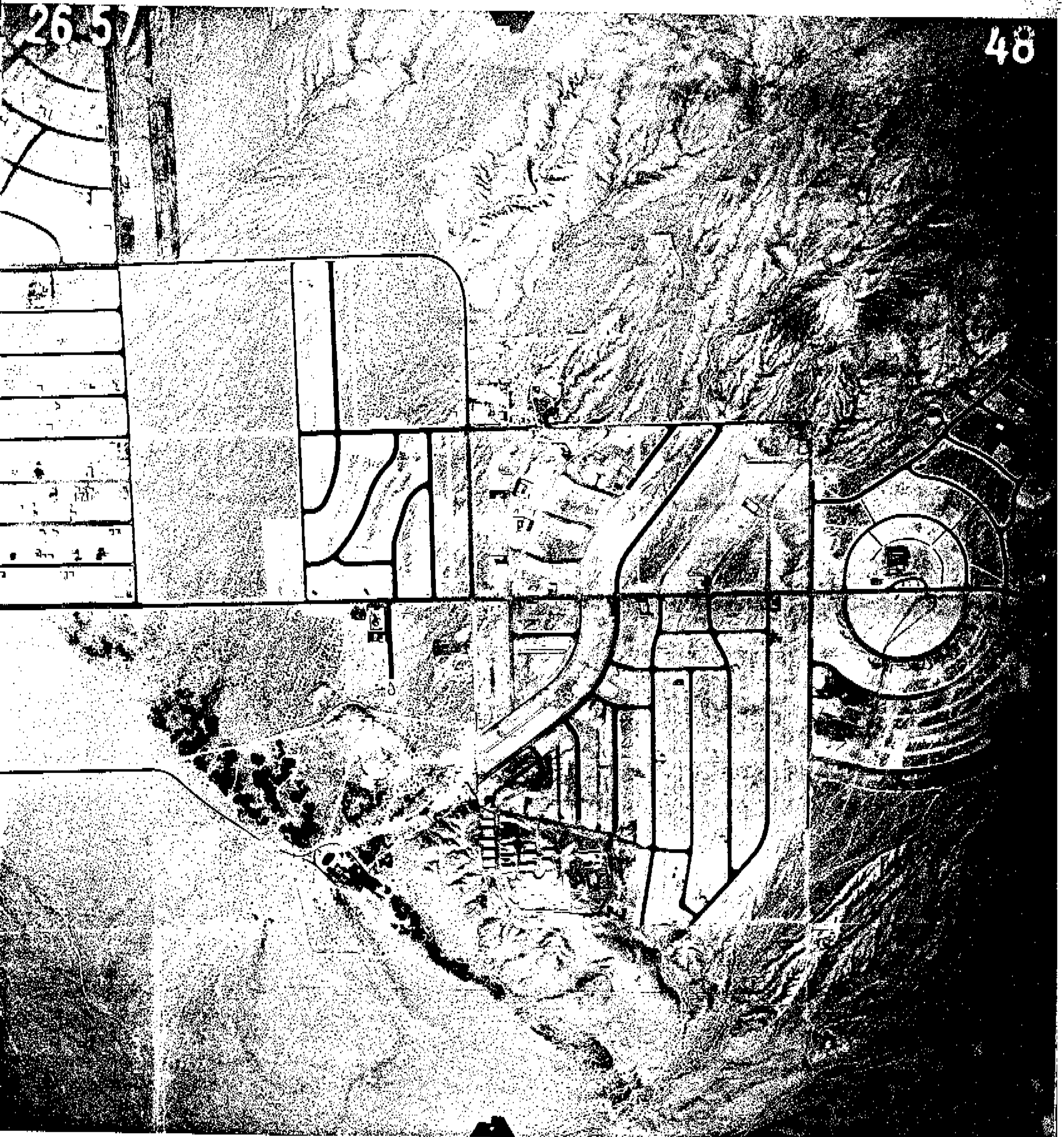
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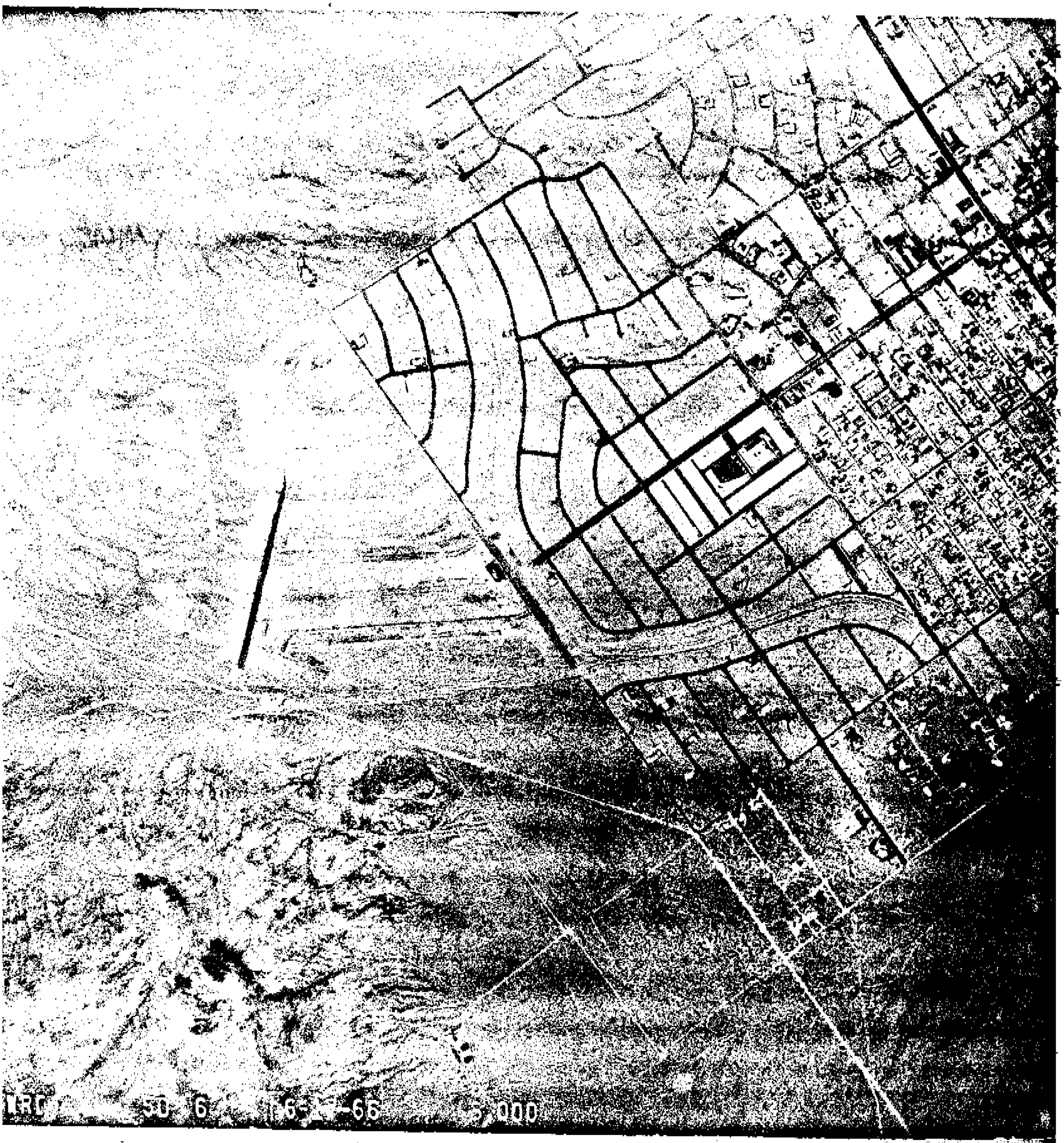
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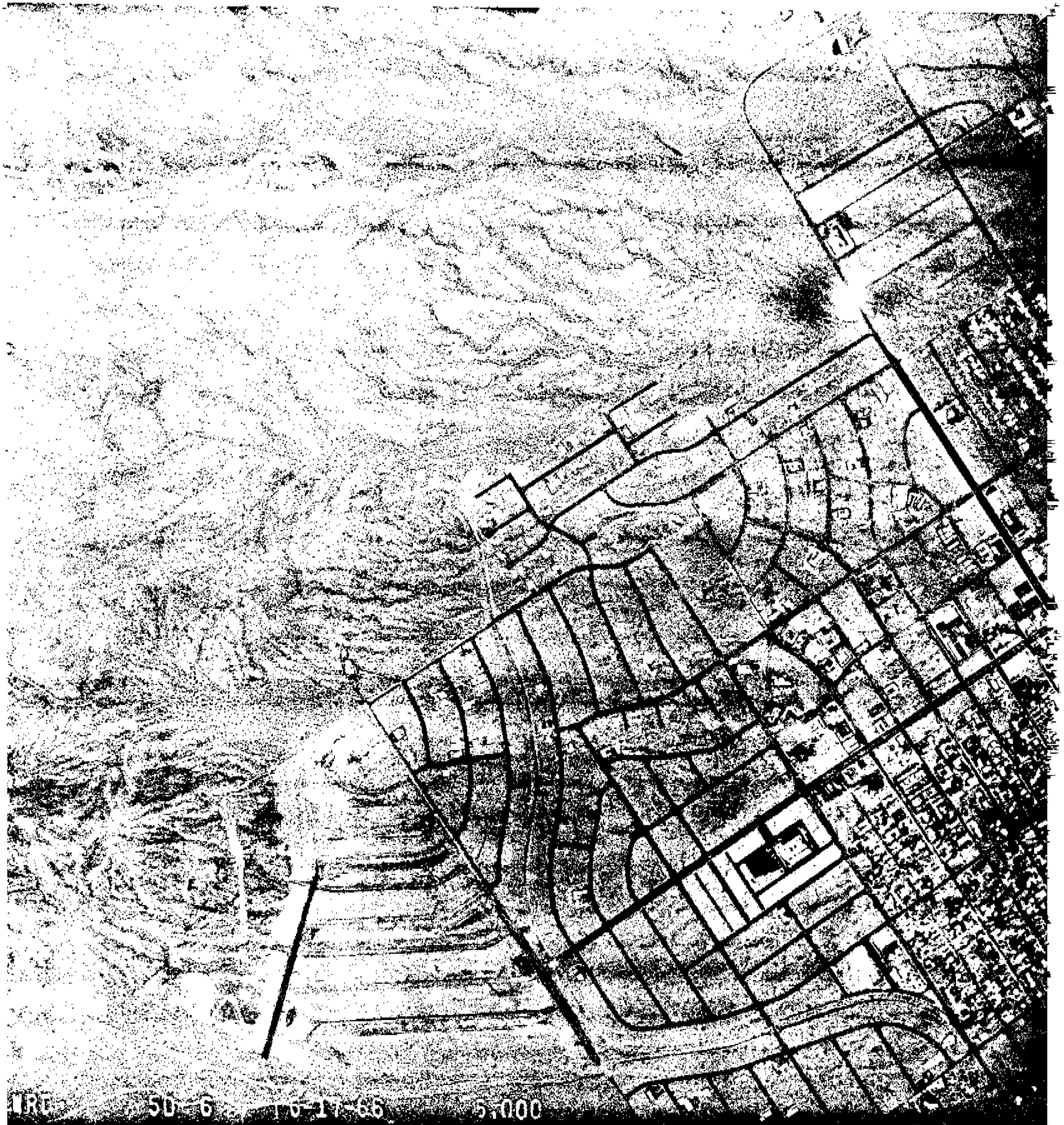
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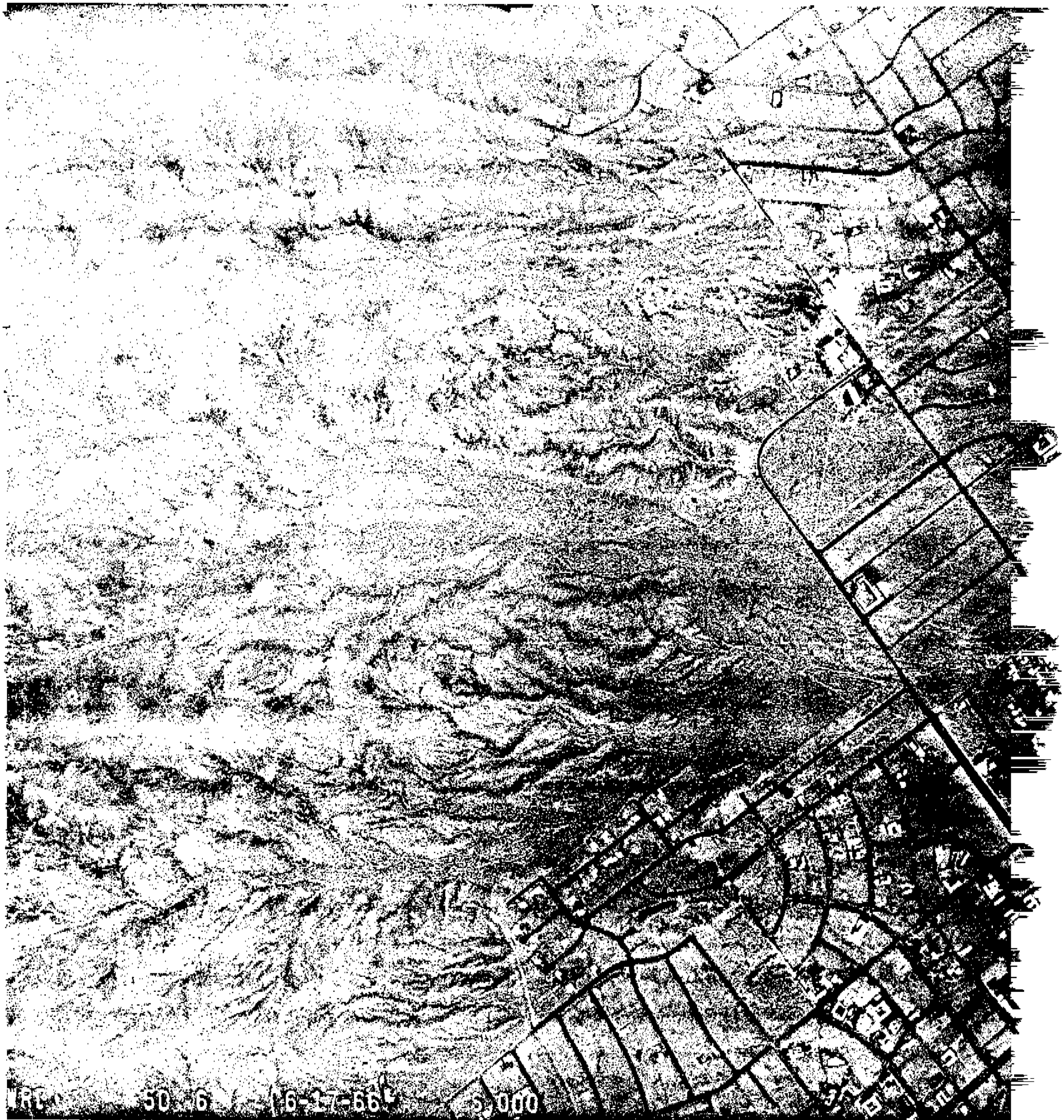

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